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(71) Applicant(s)
Bayerische Motoren Werke AG
(Incorporated in the Federal Republic of Germany)
Petuelring 130, BMW Haus, D-800 München 40, Federal Republic of Germany

(72) Inventor(s)
Martin Ranson
Paul Thomas Faithfull

(74) Agent and/or Address for Service
Bromhead & Co
37 Great James Street, LONDON, WC1N 3HB, United Kingdom

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(56) Documents Cited
GB 2217277 A EP 0575152 A

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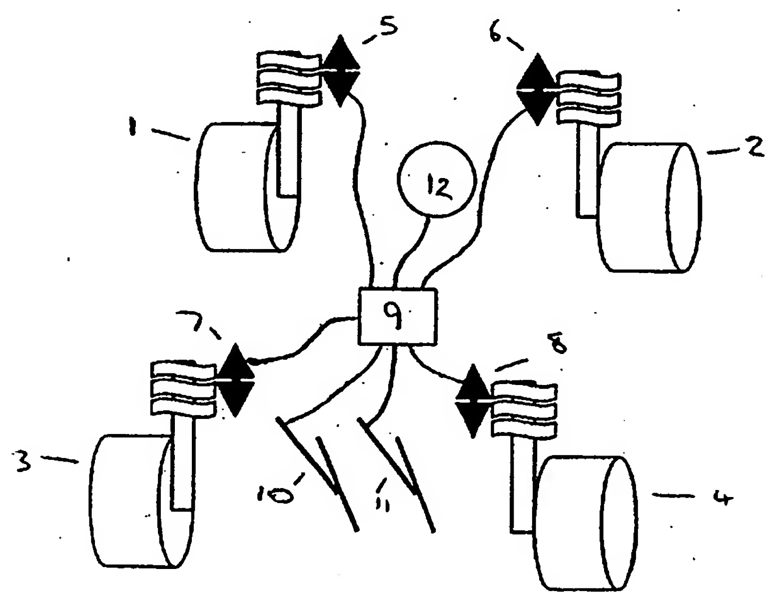
(54) Abstract Title

**A motor vehicle with controllable drive torque distribution between each of its driven wheels responding to vehicle load**

(57) A motor vehicle includes load measuring means (11) for each of its wheels and independent drive motors (12) for each of its wheels. A control unit (16) continually monitors the load on each of the wheels 1, 2, 3, 4 and distributes the drive torque accordingly, the wheels with the highest load being supplied with the highest driving torque. The load distribution is also measured before the vehicle starts moving so that the torque distribution can be optimally determined as soon as the vehicle starts off.

Fig 1




GB 2 358 163 A

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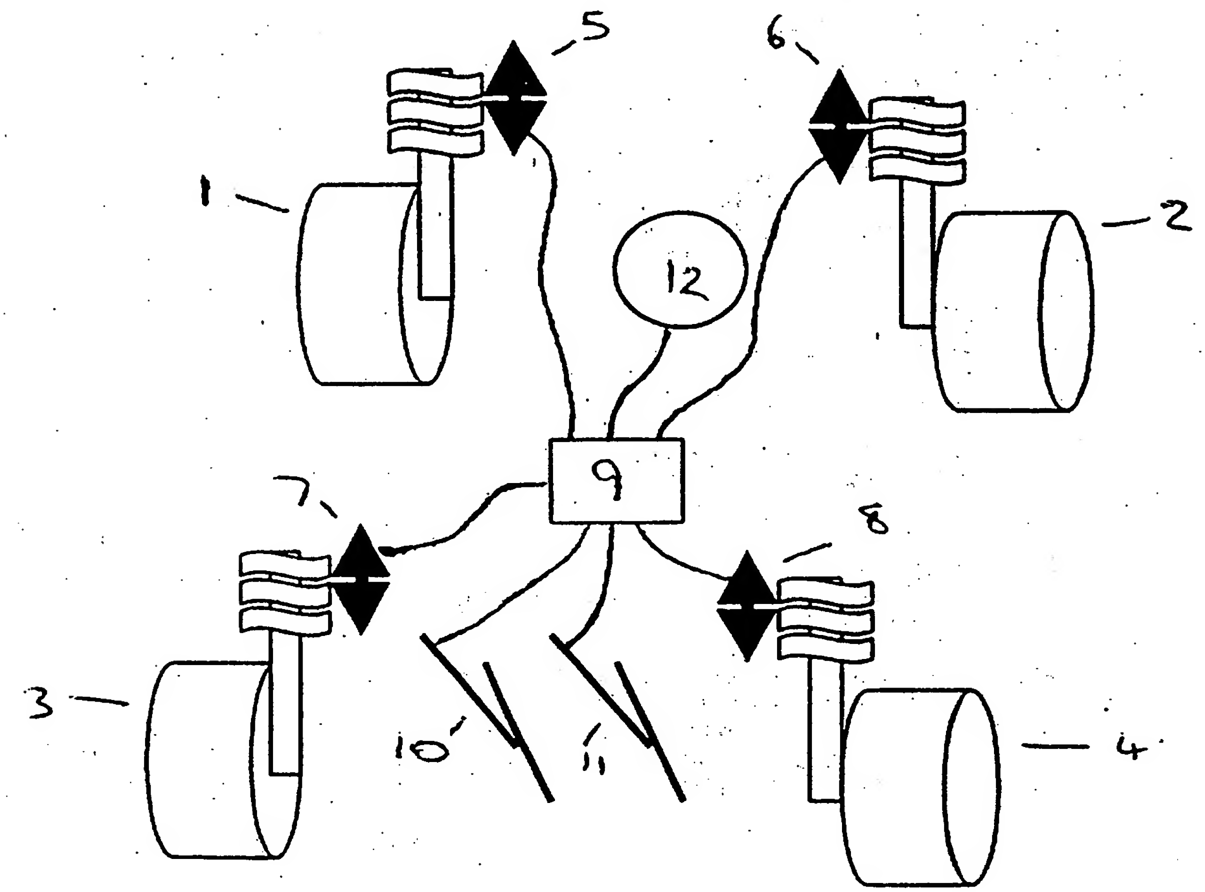
Fig 1



A Motor Vehicle

The present invention relates to motor vehicles and in particular to vehicles in which the drive torque distribution between the wheels of the vehicle can be controlled and changed.

The present invention provides a vehicle having a plurality of wheel sets, each set comprising at least one wheel, measuring means for measuring the weight supporting load on each of the wheel sets, drive means for applying a driving torque to each of the wheel sets, the magnitude of each driving torque being variable independently of the others, and control means for controlling the distribution of driving torque between the wheel sets on the basis of the measured weight supporting loads of the respective wheel sets.

The sets may each comprise only one wheel, or they may each comprise two wheels, for example the front two wheels of the four wheeled vehicle forming one set and the rear two wheels forming another.

Preferred embodiments of the present invention will now be described by way of example only with reference to the accompanying drawings in which:

Figure 1 is a schematic view of a vehicle according to the invention.

Referring to Figure 1, a vehicle has two rear wheels 1, 2 and two front wheels 3, 4. The wheels 1, 2, 3, 4 are connected to the vehicle body by an independent suspension system, including a suspension strut 5, 6, 7, 8 for each wheel which includes a spring 9 and an actuator 10. A ride height sensor in the form of a displacement transducer 11 is also provided for each strut 5, 6, 7, 8.

The drive torque to each of the wheels is independently controllable, and in this embodiment is provided by means of four electric motors 12 one for each wheel. As an alternative the drive torque can be produced at a single source, such as an internal combustion engine or a single electric motor, and the proportion transmitted to each wheel controlled by means of an actively controlled differential mechanism.

A control unit 16 controls the electric motors 12 and the suspension struts 5, 6, 7, 8 on the basis of various inputs, inter alia from the ride height sensors 11, from transducers 17, 18 indicating the position of a brake pedal 19 and accelerator pedal 20, and also from an inclinometer 21.

During operation the control unit 16 can continually monitor the load on each of the wheels 1, 2, 3, 4. It can either do this simply by measuring the ride height at each wheel, or if the suspension is operating actively it can do it by raising the ride height at each wheel by a small amount by means of the actuator 10 and, from the amount of force required to do this, determining the load at each wheel.

In operation, the control unit 16 first monitors the load on each of the wheels 1, 2, 3, 4 while the vehicle is stationary. From the load distribution, the control unit 16 determines the optimum torque distribution between the wheels in preparation for when the vehicle starts off from rest. As soon as the driver starts the vehicle moving, the torque is provided to the wheels in the optimum rations so as to provide maximum traction, the wheels with the highest loads being driven with the highest torque.

Then, as the vehicle is being driven the control unit 16 continues to monitor the loads on all of the wheels 1, 2, 3, 4. If the weight distribution between the wheels changes, the driving torque distribution can be changed accordingly. This

allows the drive torque distribution to be optimized to account for changes in the inclination of the ground on which the vehicle is travelling. For example if the vehicle is climbing a steep hill a high proportion of the load will be on the rear wheels 1, 2, and those wheels will therefore be driven with a high proportion of the total driving torque. If the vehicle then suddenly goes over the top of the hill and starts to descend, a large proportion of the weight will be transferred to the front wheels 3, 4, and the drive torque can be redistributed accordingly. Similarly of the vehicle turns so that it is traversing a slope, the weight will be supported more on the downhill side of the vehicle than on the uphill side. The drive torque will again be redistributed so that more is applied to the wheels on the downhill side than to those on the uphill side. This can help to improve traction.

In order to enhance the responsiveness of the system, the control unit 16 also monitors the level of braking and the level of acceleration demanded by the driver by monitoring the position of the brake and accelerator pedals 19, 20. Because changes in braking and acceleration result in a change of the distribution of load between the front and rear of the vehicle in a substantially predictable manner, the change in demanded braking or acceleration can be used to determine the optimum front / rear torque distribution before the resulting weight shift occurs. The torque distribution can therefore be controlled to follow closely the load distribution as it occurs, rather than just in response to its having occurred.

It will be appreciated that the invention can also be applied to four-wheel-drive vehicles in which the drive torque distribution between the front and rear of the vehicle can be controlled by means of an active differential mechanism. In such a system, the front / rear load distribution can be measured and the torque split between the front pair of wheels and the rear pair of wheels be determined on the basis of the proportion of the vehicle's load being carried by each pair. Obviously this will improve traction in situations where the vehicle changes from climbing to

the control the distribution of driving torque accordingly to account for resulting shifts of load between the front and rear of the vehicle.

7. A vehicle according to any foregoing claim wherein the control unit is arranged to monitor the level of acceleration demanded by driver and to control the control the distribution of driving torque accordingly to account for resulting shifts of load between the front and rear of the vehicle.

8. A vehicle substantially as hereinbefore described with reference to the accompanying drawings.

**Application No:** GB 0000506.6
**Claims searched:** 1-8

**Examiner:** Kevin Hewitt
**Date of search:** 17 April 2000

## Patents Act 1977
## Search Report under Section 17

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): B7H (HXG)

Int Cl (Ed.7): B60K (23/00, 23/04, 23/08)

Other: Online WPI, EPODOC, JAPIO

**Documents considered to be relevant:**

| Category | Identity of document and relevant passage | | Relevant to claims |
|---|---|---|---|
| A | GB 2217277 A | (Honda) See abstract and Figs. 1,4,5 & 6 | 1 |
| A | EP 0575152 A1 | (Mitsubishi) See Fig.1 and abstract. | 1 |

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| X | Document indicating lack of novelty or inventive step | A | Document indicating technological background and/or state of the art. |
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